Feeding of Cassava Hay for Lactating Dairy Cows

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ABSTRACT : Whole cassava (*Manihot esculenta, Crantz*) crop was harvested about 10-15 cm above ground at 3 months after planting and sun dried for 1-3 days or until the leaves were crispy-dried and the branches and stems were mostly wilted to produce cassava hay. Cassava hay (CH) contained 86.3% DM, 8.9% ash, 23.6% CP, 44.3% NDF, 30.0% ADF, 5.8% ADL, 0.257% condensed tannin and 0.35 mg % HCN, respectively. In addition, CH contained relatively higher amino acid than alfalfa hay especially methionine, isoleucine, leucine and lysine. Ruminal fermentation of CH resulted in high concentrations of C_2, C_3 and C_4 at 72, 17 and 7 mol/100 mole, respectively. A feeding trial was conducted to study on effect of feeding of cassava hay in late lactating dairy cows fed on urea-treated rice straw during the dry season on their intake, ruminal pH, NH_3-N, milk yield and compositions. Thirty, Holstein-Friesian crossbred cows in their first lactation were randomly assigned in a randomized complete block design to receive five different dietary treatments: T1=supplementation of concentrate to milk yield at 1:2, T2=supplementation of concentrate to milk yield at 1:2+0.56 kg DM, T3=supplementation of concentrate to milk yield at 1:3+1.3 kg DM CH, T4=supplementation of concentrate to milk yield at 1:4+1.70 kg DM CH, T5=CH fed on ad libitum+small concentrate supplement. All cows received urea-treated rice straw as a roughage source throughout a 80 d feeding trial. The experiment revealed that cassava hay contained high level of protein and minimal level of tannin at 3 months of harvest. Tannin intake ranged from 1.44 to 13.36 g/hd/d and did not affect on urea-treated rice straw intake. Milk yield across treatments were similar (5.4-6.3 kg/hd/d) ($p>0.05$) but 3.5% FCM was highest in cows received CH at 1.70 kg/hd/d. Feeding of cassava hay resulted in increasing milk fat (4.0 to 4.6%) ($p<0.05$) and milk protein (3.8 to 5.3%) ($p<0.05$). Moreover, the use of CH could reduce concentrate supplementation to milk yield from 1:2 to 1:4, respectively, thus resulted in more milk income return. (***Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 4 : 478-482***)

Key Words : Cassava Hay, Tannin, Roughage, Dairy Cows, Milk Yield, Milk Compositions

INTRODUCTION

Seasonal variation has a great impact on available quantity and quality of feeds for ruminants especially for dairy cattle in the tropics. During a long dry season, dairy cattle generally depend on crop-residues and by products such as rice straw as a major roughage source hence supplementation of good quality concentrate is generally required. Cassava or tapioca (*Manihot esculenta, Crantz*) is an important cash crop widely grown in sandy loam soil, low fertility and under hot long dry season. Its' leaves collected at harvesting time, contained high level of protein, and could be used as a protein supplement in ruminants (Reed et al., 1982; Bezkorowajnyi et al., 1986; Wanapat et al., 1989, 1992), however, the use of dried cassava leaves or silage had been limited due to its high level of condensed tannin (Reed et al., 1982; Onwuka, 1992). Comprehensive reviews on the effect of plant tannins on animal nutrition and feeding have been reported by McLeod (1974), Barry (1988), Reed (1995). Whole CH was introduced into a dry season feeding system for ruminants by managing cassava crop growth in order to obtain optimal yield and good quality CH (Wanapat et al., 1997, 1999). However, under this present experiment, it was the aim to study on the use of CH with various levels of concentrate supplementation in dairy cattle fed on urea-treated rice straw as a roughage source.

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MATERIALS AND METHODS

Cassava hay preparation

Cassava crop was planted densely at 30×40 cm between plant and row in a well-prepared soil which was fertilized with cow manure at 300 kg (fresh) per acre and stripped in row with *Leucaena leucocephala* in every 10-15 rows of cassava. This *Leucaena* will help enrich the soil and be harvested after 6 months and thereafter as a foliage for cattle as well. Further details in regards to CH production could be found in earlier reports (Wanapat et al., 1997, 1998).

Feeding trial

Thirty Holstein-Friesian crossbreeds in their first lactation and with day-on-milk of 150-210 were assigned in to a randomized complete block design to receive 5 different dietary treatments. Treatments were as follows;

T1: Supplementation of concentrate to milk yield at 1:2+0 kg CH/hd/d,
T2: Supplementation of concentrate to milk yield at 1:2+0.56 kg DM CH/hd/d,
T3: Supplementation of concentrate to milk yield at 1:3+1.13 kg DM CH/hd/d,

Table 1. Chemical compositions of experimental feeds

	DM	Ash	CP	NDF	ADF	ADL	Condensed tannin	HCN
	%	% of dry matter						mg%
Urea-treated (5%) rice straw	53.7	17.5	7.6	80.5	56.6	12.0		
Cassava hay (whole crop)	86.3	8.9	23.6	44.3	30.0	5.8	0.257	0.35
Concentrate	88.4	26.6	17.7	48.7	35.9	5.2		

Table 2. Comparison of amino acid profiles of cassava hay (CH) and alfalfa hay (AH)

Amino acid	CH	AH	Amino acid	CH	AH
	g/100g DM			g/100g DM	
Alanine	6.3	n.a	Phenylalanine	1.9	0.8
Proline	2.9	n.a	Lysine	1.7	0.6
Tyrosine	1.8	0.4	Asparagine	6.8	n.a
Valine	2.4	0.7	Glutamine	9.6	n.a
Methionine	0.6	0.2	Serine	2.8	n.a
Cystine	0.3	0.2	Glycine	2.6	1.9
Isoleucine	13.1	0.7	Histidine	1.5	1.2
Leucine	2.9	1.1	Arginine	2.4	3.8

n.a=not available.

T4: Supplementation of concentrate to milk yield at 1:4+1.70 kg DM CH/hd/d,

T5: Cassava hay was fed on ad lib. with 2 kg/hd/d cassava chip+3% urea

Feeding trial lasted for 80 d during which urea-treated rice straw (5%; 5 kg urea+100 kg water poured onto 100 kg rice straw and stored for 10 days before feeding; Wanapat, 1985), was given on *ad libitum* basis. All the cattle were individually penned and water was available at all times. In addition, the cattle were allowed to exercise in an allocated area for about one hour every day. All animals were dewormed and injected with vitamin A, D and E prior to commencing the experiment. Concentrate mixture containing 17% CP was given to animals according to dietary treatments and milk yield at two equal parts during morning to dietary and afternoon milking times. Urea-treated rice straw and concentrate were sampled to be analyzed for chemical compositions. Rumen fluid was taken by stomach tube with vacuum pump at 4h post feeding to be analyzed for pH immediately, and for later analysis of NH_3-N. (Bremner and Keeney, 1965). Milk yield was recorded daily and composited samples from mornings and afternoons were analyzed using Milko Scan. Cassava hay was prepared according to Wanapat et al. (1997) using cassava crop grown after 3 months and its regrowth (every two months), sun-dried 1-3 days and stored for later feeding. Further details of CH preparation can be found in Wanapat et al. (1997, 1998). Feeding of CH was done at milking time according to respective treatments accept for treatment on *ad libitum* basis.

Amino acid profiles and ruminal volatile fatty acids of CH were analyzed by using HPLC (Sammuel et al., 1997) collecting from four rumen fistulated dairy steers which were fed on CH for a continuous period of four weeks. Condensed tannins were analyzed by the vanillin-HCL method of Broadhurst and Jones (1978).

Statistical analysis

All data were subjected to analysis of variance using Proc. GLM and treatment means were statistically compared by Duncan's New Multiple Range Test (SAS, 1996).

RESULTS AND DISCUSSION

Table 1 illustrates details of chemical compositions of experimental feeds. Urea-treated rice straw contained 53.7% DM and 7.6% CP on dry matter basis. Cassava hay had 23.6% CP which was slightly lower than the value earlier reported by Wanapat et al. (1997, 1998). The lower value may have been attributed by having higher portion of stem to leaf containing in the CH itself. The CP content of concentrate and cassava chip plus urea used as supplements contained 17.7% (T1-T4) and 10.8% (T5), respectively. Concentrates were offered into two equal parts during milking times and were well consumed by the cows in respective treatments.

Amino acid profiles of CH and AH are presented in table 2. CH contained relatively higher levels of amino acids especially isoleucine, glutamine, asparagine methionine, lysine and alanine. These amino acids could potentially be digested and absorbed in the lower gut since CH contained condensed tannin and could form tannin-protein complex for gut digestion. As reported by Barry and Manley (1984), tannins may form tannin-protein complex in the rumen and were unstable at acid pH in the lower gut which would render protein available for digestion. Data on total volatile fatty acid (TVFA) concentrations of CH were reported in table 3. TVFA increased as time of fermentation in the rumen progressed from 0 to 4 h. Acetate (C2), propionate (C3) and butyrate (C4) concentrates were relatively high which would act as substrates for milk fat synthesis (C2 and C4) and sources of energy-yielding, glucose and NADPH, necessary for milk bio-synthesis. However, recent data suggested that tannins improved rumen efficiency by decreasing C2 and increasing C3 and enhancing microbial protein synthesis in the vitro system (Makkar et al., 1995).

Data on intakes, milk yield and composition are presented in table 4. The CH intakes were 0, 0.56, 1.13, 1.70 and 5.20 kg DM/hd/d in treatment 1, 2, 3, 4 and 5, respectively. As the level of CH supplemented increased, the amount of condensed tannin increased from 1.44 to 13.36 g/hd/d which did not affect on overall intake of roughage. This level was much lower than the value reported to have an adverse affect on intake and digestibility (Kumar and Singh, 1984; Barry, 1989). Supplementation of CH at 1.70 kg/hd/d (T4), remarkably enhanced urea-treated rice straw intake ($p<0.05$) while ruminal pH, NH_3-N were similar among treatments, however, lower values especially NH_3-N were found in cattle fed CH on *ad libitum* basis. As reported by Wanapat et al. (1997),

Table 3. Ruminal volatile fatty acids (VFA) production in dairy steers fed on cassava hay

Time after feeding (h)	TVFA	C_2	C_3	i-C_4	C_4	i-C_5	C_5	C_4:C_3
	mM/l	mol/100 mol						
0	40	73	16	1.5	6	2.6	0.7	4.5
2	43	71	17	1.2	7	2.1	0.9	4.1
4	50	71	18	1.2	8	1.8	1.1	4.0
Mean	44.5	72	17	1.3	7	2.1	0.9	4.2

Table 4. Effects of cassava hay (CH) supplementation levels on ruminal pH, NH_3-N, milk yield and milk compositions in late lactating cows fed urea-treated rice straw (UTRS) as a roughage

	T1	T2	T3	T4	T5	SEM
Cassava hay DM intake, kg/d	-	0.56	1.13	1.70	5.2	0.20
Condensed tannin intake, g/hd/d	0	1.44	2.90	4.37	13.36	5.26
Conc. saving, kg/hd/d	-	0.10	1.30	1.60	3.1	-
Urea-treated rice straw						
DM intake						
kg/d	6.8	6.4	6.7	8.0	-	0.28
g/kg $W^{0.75}$	86	69	84	98	-	2.82
% BW	2.0	1.8	2.0	2.3	-	0.06
Ruminal pH	7.2	7.0	7.0	7.0	6.8	0.13
Ruminal NH_3-N, mg/dl	17	13	13	16	7.0	0.52
Milk yield, kg/d	6.3	6.1	5.4	6.1	5.4	0.24
3.5% FCM, kg/d	6.8^{ac}	6.2^{ab}	6.0^{b}	7.1^{c}	6.4^{ab}	0.13
Milk fat,%	4.0^{a}	3.6^{b}	4.2^{a}	4.5^{c}	4.6^{c}	0.11
Milk protein, %	4.4^{a}	4.0^{a}	3.8^{a}	4.1^{a}	5.3^{b}	0.17
Solids-not-fat, %	8.6	8.8	8.4	8.6	8.4	0.12
Total solids, %	12.6	12.3	12.0	12.2	12.6	0.18

^{a,b,c} Values on the same row with different superscripts differ ($p<0.05$).

T1=Urea-treated rice straw (UTRS *ad lib.*+ Conc: Milk yield (1:2)+0 CH.

T2=UTRS *ad lib.*+Conc: Milk (1:2)+CH at 0.56 kg DM/hd/d.

T3=UTRS *ad lib.*+Conc: Milk (1:3)+CH at 1.13 kg DM/hd/d.

T4=UTRS *ad lib.*+Conc: Milk (1:2)+CH at 1.70 kg DM/hd/d.

T5=Cassava hay *ad lib.*+Cassava (cassava chip+3% urea) at 2 kg/d.

* Concentrate mixture in this treatment contained 95% cassava chip, 3% urea, 1% sulfur and 1% mineral mix.

CH contained tannin-protein complex which may have provided ruminal by-pass protein and thus lowered ruminal NH_3-N.

Sun-drying of whole cassava crop to produce hay has resulted in appreciably reducing hydro-cyanic acid content to 0.35 mg% which agreed with the work reported by Gomez and Valdivieso (1985). The level of HCN intake (1.8 g/hd/d) in the CH fed group on ad libitum was considered to be very low and safe since ruminants generally have abilities to detoxify by ruminal microbes by means of methylation forming thiocyanate with presence of sulfur (Reed, 1995). It was also reported that thiocyanate present in milk (20 ppm) could act as a preservative by activating the milk lacto-peroxidase system (LPS) hence inhibits bacterial growth (Claesson, 1994).

Milk yield were similar among treatments however, 3.5% fat corrected milk were highest in T4. Fat contents of milk were higher in CH supplemented groups especially in the *ad libitum* fed group. Cassava hay could have provided additional volatile fatty acids necessary for milk fat synthesis. Higher milk fat percentage was a good indicator for higher milk cost since the sale of milk was based on fat content. Moreover, milk protein content was highest in T5. Higher ruminal by- pass protein (tannin-protein complex) of CH could have affected on this improvement (Wanapat et al., 1997, 1998).

As clearly demonstrated, as levels of cassava hay supplementation increased, the concentrate supplement use was remarkably reduced from 0.10 to 3.1 kg/hd/d, respectively. This reduction would certainly have a great impact on the cost of production since feed cost accounted for most of the overall production cost (70-80%). As shown in table 4, net savings of using concentrate were paramount ranging from 0 to 3.1 kg/hd/d as CH was supplemented or used on ad libitum which would result in higher income. Based on this experiment, CH could be a good source of high quality roughage for dairy cows during the dry season in the tropics.

CONCLUSIONS

Cassava hay could be easily produced on farm since it required minimal management input in a low fertile soil and could thrive well during hot weather. Based on this experiment, the results suggest that CH supplementation resulted in similar milk yield and improved milk fat and protein in lactating dairy cows. Higher level of CH supplementation significantly reduced concentrate use to lower level as 1:4 (conc : milk) which could provide more economical return to farmers since concentrate use and cost accounted very high (70% of total production cost). Cassava hay should be recommended to be produced and used on farm for dairy production in the tropics as a source of high protein roughage which contained tannin-protein complex. However, further studies on CH supplementation in early to mid-lactation warrant undertakings.

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